**IS 234 : 2013**
**[Amalgamating IS 10014 (Part 2) : 1981]**

(Reaffirmed 2017)
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*भारतीय मानक*

# वस्त्रादि — वस्त्रादि रेशों के रैखिक घनत्व ज्ञात करना (भारात्मक एवं वाईब्रोस्कोप विधि) — विशिष्टि

*( दूसरा पुनरीक्षण )*

*Indian Standard*

# TEXTILES — METHOD FOR DETERMINATION OF LINEAR DENSITY OF TEXTILE FIBRES (GRAVIMETRIC AND VIBROSCOPE METHOD) — SPECIFICATION

*( Second Revision )*

ICS 59.060

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**BUREAU OF INDIAN STANDARDS**
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NEW DELHI 110002

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Physical Methods of Test Sectional Committee, TXD 01

## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Physical Methods of Test Sectional Committee had been approved by the Textile Division Council.

This standard was first published in 1952 and revised in 1973.This standard has been further revised amalgamating it with IS 10014 (Part 2) : 1981 'Methods of tests for man-made staple fibres: Part 2 Determination of linear density'. Accordingly IS 10014 (Part 2) shall stands withdrawn.

In the case of natural fibres such as cotton, there is considerable variation in the linear density from fibre to fibre and even amongst the fibres of the same seed. As a large number of fibres have to be tested to get a fairly reliable result, whole fibre methods are time consuming and laborious. In the case of man-made fibres, there is practically no variation in linear density along the length of the fibre, it is more convenient to adopt cut fibre bundle method to determine the linear density within the acceptable level of precision. Whole fibre method is, therefore, hardly used in textile industry. The option of determination of linear density by whole fibre method has been dropped in this standard.

Considerable assistance has been derived from ISO 1973: 1999 'Determination of linear density of textile fibres—Gravimetric method'.

Examples of calculation of mean linear density is given in Annex A for guidance only.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# *Indian Standard*

# TEXTILES — METHOD FOR DETERMINATION OF LINEAR DENSITY OF TEXTILE FIBRES (GRAVIMETRIC AND VIBROSCOPE METHOD) — SPECIFICATION

## *( Second Revision )*

## 1 SCOPE

**1.1** This standard prescribes gravimetric and vibroscope method for determination of linear density of textile fibres. The gravimetric method is applicable to fibre bundles cut to a definite length. The vibroscope method is applicable for single fibres of long and medium staple samples. It is not applicable to short staple fibres, for example cotton.

**1.2** Both the methods given are applicable only for discrete fibres (excluding fibres like Jute) which can be kept straight and in the case of bundles, parallel during test preparation. They are not applicable for blends having different nominal linear densities. They are not applicable to taper fibres and fibre having pronounced crimp (such as Indian wools).

NOTE — For high-modulus fibres (for example, aramid fibres) the use of the vibroscope method should be agreed to by the interested parties, because the high stiffness of such fibres may influence the results.

## 2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

| *IS No.* | *Title* |
|---|---|
| 232 : 1985 | Glossary of textile terms — Natural fibres (*second revision*) |
| 4807 : 1968 | Methods of testing viscose yarn staple fibres |
| 4952 : 1968 | Methods for sampling of cotton bales, slivers and rovings |
| 6359 : 1971 | Method for conditioning of textiles |

## 3 PRINCIPLE

### 3.1 Method I (Gravimetric Method)

A tuft having known number of fibres is cut in the middle to a known length and the mass of the cut-middle portion is determined. From the mass and total length of fibres the linear density is calculated.

### 3.2 Method II (Vibroscope Method)

Individual fibres of given length and under specified tension are subjected to vibration at resonance frequency. The linear density is determined from the conditions of the resonance state, that is the resonance frequency, the length of the fibre and the tensioning force. The linear density is read directly on the scale of the vibroscope apparatus. This method assumes that the linear density of the tested length of the fibre is constant.

## 4 TERMINOLOGY

For the purpose of this standard the definitions given in IS 232 and the following shall apply.

**4.1 Millitex —** The mass in milligrams per kilometre length of fibre.

NOTE — 1 mtex (millitex) = 0.001 tex

**4.2 Decitex** — The mass in decigrams per kilometre length of fibre.

NOTE — 1 dtex (decitex) = 0.1 tex

**4.3 Denier —** The mass in grams of 9 km length of fibre.

**4.4 Linear Density** — Mass per unit length; the quotient obtained by dividing the mass of the fibre by its length. It is expressed in millitex, decitex or denier.

**4.5 Tension** — Force tending to cause the extension of a body.

**4.6 Tensioning Force** — Force effective on a fibre specimen during the vibroscope test.

## 5 ATMOSPHERIC CONDITIONS FOR CONDITIONING AND TESTING

The test sample shall be conditioned as laid down in IS 6359 and test carried out in the standard atmospheric conditions of 65 ± 2 percent relative humidity and 27 ± 2°C temperature.

## 6 SAMPLING

The test samples of fibres shall be so selected as to be the representative of the lot. The samples drawn in accordance with the procedure laid down in the material specification or in compliance with an agreement between the buyer and the seller shall be held to be the representative of the lot.

NOTE — In case of cotton and viscose rayon fibres reference to IS 4952 and IS 4807 respectively may be made.

## 7 PREPARATION OF TEST SAMPLE

**7.1** The test sample from the gross sample shall be prepared as given in **7.2** and **7.3**.

**7.2** The gross samples approximately 1 kg shall be spread out evenly on a level ground in the form of either a square with each side slightly greater than 1 m or in the case of a larger sample, a rectangle with the shorter side slightly greater than 1 m and the larger side slightly greater than 2 m. Over this, a metallic framework of size 1 m × 1 m with 25 sub-squares or 1 m × 2 m with 50 sub-squares, as the case may be, shall be placed. From each of these sub-squares one bunch (or more) of fibres shall be pulled out at random, taking care (a) not to exercise any bias in favour of or against any particular place within a sub-square, and (b) that the fibres drawn from each sub-square weigh about the same amount. The total quantity of about 6 g to 10 g of fibres drawn shall constitute the reduced sample.

**7.3** The reduced sample shall be divided into 25 or 50 approximately equal groups. From a different portion of each of these groups one small tuft (or more) of fibres shall be extracted at random, taking care that the fibres drawn are nearly equal in weight, and the total weight of fibres thus drawn is not less than 200 mg. This shall constitute the 'test sample'.

## 8 TESTING

After pre-conditioning, bring the sample to constant mass in the standard atmosphere. Carry out the test without removal from the standard atmosphere by Method I (*see* **9**) or Method II (*see* **10**).

## 9 METHOD I — CUT FIBRE BUNDLES

### 9.1 Apparatus

**9.1.1** Means for cutting a fibre bundle to an accuracy of known length.

NOTE — A convenient cutter consists of two sharp razor blades set parallel 20 mm (for long and medium staple fibres like polyester, nylon, etc) or 10 mm (for short staple fibres such as cotton) apart in a holder.

**9.1.2** *Forceps,* for collecting the fibres.

**9.1.3** *Black Velvet Pad*

**9.1.4** *Microbalance,* suitable for weighing the bundles of fibres to an accuracy of 0.005 mg.

**9.1.5** *Steel Comb,* having about 12 needles/cm.

**9.1.6** *Magnifying Glass*

**9.1.7** *Glass Slide*

### 9.2 Procedure

**9.2.1** Select five tufts from a well spread out sample. Parallelize them thoroughly by gently combing both sides alternately. Clamp one end of a tuft and again parallelize them. Apply a suitable tension sufficient to remove the crimp in the fibres and grip the free end of the tuft. Ensure that all the fibres are caught at both the grips. Using a cutter cut the middle portion. Collect the fibres and place on the velvet pad (*see* Note 1). Cover it with a glass slide. Collect 100 fibres and weigh in the microbalance to an accuracy of 0.005 mg. Repeat the procedure with the remaining four tufts.

NOTES

**1** The operation of combing the tufts, parallelization, cutting, etc are done prior to preconditioning and conditioning of the test specimens. This will ensure that the fibres are not handled after conditioning.

**2** A magnifying glass will help to avoid miscounting the fibres while collecting.

**3** Cutting should be carried out in such a way that there is no lateral movement of the fibres while cutting. This can be ensured by placing the fibre bundle under tension over a rigid base with the fibres lying straight on the base.

**4** Tension to be applied is tex/2 or denier/18 which can be obtained by a preliminary test.

### 9.3 Calculation

**9.3.1** Calculate the linear density in millitex or denier using the following equation (*see also* Note) :

$$\text{mtex (millitex)} = \frac{m}{n \times l} \times 10^6$$

or

$$\text{d (denier)} = \frac{m}{n \times l} \times 9\,000$$

where

$m$ = mass of the bundle of fibres, in mg;

$n$ = number of fibres (100 in this case); and

$l$ = cut length, in mm.

NOTE — Substitute the mass of the bundle of fibres, in decigram, and cut length, in decimetre, for expressing linear density, in decitex.

**9.3.2** Calculate the linear density of the four remaining tufts.

**9.3.3** Calculate the average of the five readings and report the average value and coefficient of variation.

NOTE — The coefficient of variation value shall be calculated as follows:

$$\text{Coefficient of variation, CV percent} = \frac{\sigma_d}{d} \times 100$$

$$\sigma_d = \sqrt{\frac{\left(d_1^2 + d_2^2 + \ldots d_5^2\right) - \frac{\left(\Sigma d_i^2\right)}{5}}{4}}$$

## 10 METHOD II — VIBROSCOPE METHOD

### 10.1 Apparatus

**10.1.1** Vibroscope having the following accuracy:

a) Applied tensioning force shall be within the range of ± 0.6 percent of the specified value.

b) Error in the vibroscope reading of resonance frequency measured or applied shall not exceed ± 0.6 percent.

c) Error in the vibroscope reading of vibration length of the fibre shall not exceed ± 0.6 percent.

### 10.2 Procedure

**10.2.1** Prior to testing carry out preliminary checking of the vibroscope as follows.

**10.2.2** Test 100 individual fibres using the vibroscope. Calculate the arithmetic mean and coefficient of variation of the vibroscope readings of linear density. If the coefficient of variation of the vibroscope readings is larger than 10 percent, the sample is not suitable for determination of linear density using this vibroscope. Test the same fibres by the gravimetric method and confirm that the difference within the acceptable limits.

**10.2.3** Weight the bundle of 100 fibres that have been tested with the vibroscope using the balance. Measure the length of all fibres with an accuracy of ±1 percent or where appropriate, cut the 100 fibres to a known length using the cutting device.

**10.2.4** Calculate the mean linear density $L$ of the fibre expressed in decitex using the following formula:

$$L = \frac{m}{\sum_{i=1}^{100} i_i} \times 10^4$$

where

$m$ = mass of the fibre bundle, in mg; and

$i_i$ = length of the $i$th fibre in the bundle in millimetres.

**10.2.5** Compare this mean linear density with the mean value of the linear density readout on the vibroscope. The relative difference shall not exceed ± 3 percent of the mean value of the vibroscope readings.

**10.2.6** From the laboratory test sample, take ten tufts having a mass of several milligrams and with these form a bundle by repeated halving and doubling. From this bundle take a tuft of at least 50 fibres and condition them as specified in **5**.

**10.2.7** Fix each of the fibres to the vibroscope under the applied tensioning force, which shall be sufficient to remove the crimp, using forceps and taking care to avoid any damage or distortion of the fibre.

**10.2.8** Calculate the tensioning force to be applied from the nominal linear density. If the nominal linear density is not known, an approximate value of the linear density shall be established by preliminary tests.

**10.2.9** Once this tensioning force has been selected, it shall be applied and maintained with the required accuracy.

**10.2.10** Normally tensions chosen within the range (0.5 ± 0.05) cN/tex are suitable.

**10.2.11** For highly crimped fibres, increase the tension to remove the crimp but not to stretch the fibre, in accordance with the vibroscope manufacturer's specification. Alterations in tensioning force shall be stated in the test report.

### 10.3 Calculations

**10.3.1** Calculate the mean of the vibroscope readings of linear density of the fibres tested, expressed in millitex or decitex to three significant figures.

**10.3.2** Calculate the coefficient of variation of the individual values for the linear density, expressed as a percentage to the nearest 0.1 percent.

**10.3.3** Calculate the 95 percent confidence interval of the mean linear density in millitex or decitex to the same precision as the mean linear density value.

**10.3.4** Calculate 95 percent confidence interval expressed as percentage of the mean linear density value.

**10.3.5** The mean of the linear density values obtained shall be taken as the mean linear density of the fibres in the sample, provided that the value of the confidence interval expressed as a percentage of the mean linear density is less than ± 2 percent.

**10.3.6** If the value of the confidence interval is too high, the number of fibres tested shall be increased until the value of the confidence interval expressed as a percentage lies within ± 2 percent.

## 11 REPORT

**11.1** The report should include the following information:

a) Type of fibres;
b) Method followed (Gravimetric or Vibroscope); and
c) Conditioning and testing atmosphere used.

**11.2 Gravimetric Test Results**

a) Length of the cut bundle;
b) Number of bundles tested;
c) Mean linear density in millitex or decitex or denier;
d) Coefficient of variation percentage, if required; and
e) 95 percent confidence interval, in millitex or decitex or denier, if required.

**11.3 Vibroscope Test Results**

a) Number of fibres tested;
b) Tensioning force used;
c) Mean linear density in millitex or decitex or denier;
d) Coefficient of variation percentage, if required; and
e) 95 percent confidence interval, in millitex or decitex or denier, if required.

# ANNEX A

(*Foreword*)

## EXAMPLES OF CALCULATION OF MEAN LINEAR DENSITY

### A-1 METHOD I — GRAVIMETRIC METHOD — BUNDLES OF 50 FIBRES

**A-1.1 Data**

a) Values of weighing of ten bundles, in mg:
   0.385, 0.388, 0.381, 0.379, 0.375,
   0.383, 0.388, 0.377, 0.400 and 0.381
b) Cut length: 50 mm

**A-1.2 Calculations**

Mean linear density of the fibre in each bundle, in decitex:

$$L = \frac{m}{nl} \quad 10^4 = \frac{m}{50 \quad 50} \quad 10^4$$

= 1.54, 1.55, 1.52, 1.52, 1.50
1.53, 1.55, 1.51, 1.60 and 1.52

where

$m$ = mass of the fibre bundle, in mg;
$n$ = number of fibres in the bundle; and
$l$ = length of the individual fibres in the bundle, in mm.

Mean linear density of the fibres in all bundles

$L$ = 1.53 dtex

Coefficient of variation

$v$ = 1.8 percent

### A-2 METHOD II — VIBROSCOPE METHOD — INDIVIDUAL FIBRES

Values of 50 individual determinations of linear density in decitex

1.51; 1.47; 1.42; 1.64; 1.38;1.40; 1.67; 1.60; 1.50; 1.73;
1.56; 1.41; 1.56; 1.44; 1.41;1.61; 1.36; 1.37; 1.49; 1.23;
1.37; 1.66; 1.58; 1.41; 1.52;1.60; 1.72; 1.71; 1.47; 1.38;
1.68; 1.63; 1.40; 1.73; 1.67;1.46; 1.28; 1.58; 1.70; 1.58;
1.53; 1.40; 1.39; 1.58; 1.38;1.53; 1.48; 1.55; 1.53; and 1.36

Mean linear density of the 50 individual fibres $L$ = 1.51 dtex

Coefficient of variation

$v$ = 8.3 percent

# ANNEX B

( *Foreword* )

## COMMITTEE COMPOSITION

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